Summer 8-13-2016

Modified Valsalva Maneuver vs. Standard Valsalva Maneuver on Emergency Department Patients Presenting with Supraventricular Tachycardia

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Abstract

Background: Supraventricular tachycardia (SVT) is a relatively common dysrhythmia among the general population and a common dysrhythmia presenting to the emergency department. Generally speaking, it is assumed the provider should attempt a vagal maneuver as first-line treatment for SVT, and the most common vagal maneuver used is the Valsalva. Current resources describing the method to perform the Valsalva are vague, and it seems that the exact procedure may vary across clinicians. Even though the Valsalva maneuver is accepted as first-line treatment, there may not be complete compliance with this maneuver and many emergency departments rely relatively heavily on adenosine as absolute treatment for SVT. Currently accepted methods for performing the Valsalva typically describe the patient in a sitting or semi-recumbent position prior to "bearing down" or straining. A modification in posture has been proposed and implemented in some settings and has the patient in a supine position for increased vagal stimulation. This modified Valsalva has shown promise to be more effective than the standard Valsalva maneuver.

Methods: MEDLINE-Ovid, CINAHL, and Web of Science were exhaustively searched using the keyword "modified Valsalva". Studies were screened using inclusion and exclusion criteria. Inclusion criteria included papers in the English language, patients presenting in SVT, and comparison of modified Valsalva to a standard Valsalva. Studies were excluded if they did not include a postural modification to the Valsalva, and had no comparison to a standard Valsalva. GRADE criteria were applied to the selected studies and assessed for quality.

Results: Primary outcome was return to normal sinus rhythm (NSR) following either control or intervention. Two studies were selected for this systematic review based on inclusion and exclusion criteria. One study was a randomized controlled trial (RCT) and contained 214 participants in both the treatment (modified Valsalva) and control (standard Valsalva) group. A second study was composed of an observational case study using the modified Valsalva and retrospective case review looking at success with a standard Valsalva maneuver.

Conclusion: There is an increase in conversion from SVT to NSR using the modified Valsalva as compared to a standard Valsalva maneuver. Also notable is the increase in conversion from SVT to NSR in the RCT control group as compared to the retrospective case review. Further research into the use of the modified Valsalva maneuver in the pediatric population should be examined as well as standardization of either Valsalva maneuver on patients presenting to the emergency department in SVT.

Degree Type
Capstone Project

Degree Name
Master of Science in Physician Assistant Studies

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A Clinical Graduate Project Submitted to the Faculty of the

School of Physician Assistant Studies

Pacific University

Hillsboro, OR

For the Masters of Science Degree, August 2016

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Biography

[Redacted for privacy]

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Background

Supraventricular tachycardia (SVT) is a relatively common cardiac dysrhythmia presenting to the emergency department (ED) in both the adult and pediatric populations.[1-3] Currently, vagal maneuvers like the Valsalva maneuver are a common and accepted first-line therapy for SVT presenting to the ED. But there is no standardized method on performing the Valsalva maneuver. It is common practice in the ED to instruct patients to perform the Valsalva maneuver by "bearing down" like they are trying to have a "bowel movement". Furthermore, cardioversion using a vagal maneuver is relatively unsuccessful in the clinical setting.[4] It is difficult to speculate the reason for the low rate of cardioversion using the Valsalva maneuver, but one possibility is patient positioning during the procedure.[5] It is important to correctly identify the dysrhythmia as SVT, because only tachycardia that involves the atrioventricular node can be possibly reversed using a vagal maneuver.[6]

The Valsalva maneuver is not without its own limitations, and contraindications including, but limited to aortic stenosis, recent myocardial infarction (MI), glaucoma, and retinopathy.[7] Furthermore, there are individuals in the population that may not be able to perform the maneuver due to the inability to follow verbal commands or lie flat (including any females in the 3rd trimester of pregnancy). Patients presenting with abnormal vital signs and patients that are "unstable" are additionally not candidates for a Valsalva maneuver, and emergency cardioversion should be considered.

Unsuccessful Valsalva maneuvers are usually followed by administration of intravenous adenosine, which is associated with considerable side effects due to its mechanism of action, which includes transient asystole, or stoppage of the heart. These side effects include a sense of impending doom experienced by the patient due to the transient asystole caused by adenosine.[8] Other possible side effects include but are not limited to: cardiac arrest, hypotension, and other ventricular dysrhythmias, all of which warrant the use of a less invasive approach to SVT cardioversion in the clinical setting.

The need for a modified and standardized Valsalva maneuver for treatment of SVT is based on the lack of specific description in reference books on how to exactly perform a Valsalva maneuver.[9-10] It is currently accepted in clinical practice to instruct patients to perform the standard Valsalva maneuver in a sitting or semi-recumbent position.[11] Research studies[4,5] focusing on patient positioning during the Valsalva maneuver have had patients placed in the supine position. It is theorized that lying a patient supine can increase vagal tone and decrease sympathetic tone as well as increase venous return during the Valsalva maneuver.[4-5, 12-14] Identifying recent research studies to support an improved Valsalva maneuver is the goal of this systematic review. Proposing a standardized Valsalva maneuver for use in emergency departments is beyond the scope of this review but is certainly an idea that needs future consideration by the medical field.

Methods

An exhaustive search was performed using MEDLINE-Ovid, Web of Science, and CINAHL. The search term "modified Valsalva" was used to search the above mentioned databases. Studies that compared the use of a standard Valsalva maneuver vs. a postural modified Valsalva maneuver on patients presenting with SVT were included.

Only studies performed on human subjects and in the English language were considered. Other inclusion criteria included subjects seen in an emergency department setting. Additionally, papers that had some means of standardizing the maneuvers were targeted. Articles were assessed for quality using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE)[15]. See Table 1.

Results

The MEDLINE-Ovid search resulted in 6 articles, the CINAHL search resulted in 8 articles, and the Web of Science resulted in 60 articles using the above mentioned search criteria. Of these articles, 2 studies met all inclusion criteria and were considered for this systematic review.[7,11] The more recent study was a randomized controlled trial[7] and the earlier study was a prospective observational study[11] that included a retrospective case review used as the comparison. See Table 2.

Appelboam et al

This study[7] was performed between Jan 11, 2013, and Dec 29, 2014 and was published in the Lancet on August 25, 2015. The investigators wanted to examine the use of a postural modification to the Valsalva maneuver and possibly adopt this modified Valsalva as a protocol in designated emergency rooms in the UK. The investigators believe that a modification to the standard Valsalva could increase the conversion of SVT to Normal Sinus Rhythm (NSR) in the ED setting and in doing so decrease the use of adenosine.[7]

This study was a randomized multicenter parallel group trial and study participants were enrolled from 10 emergency departments in southwest England between Jan 1, 2013 and April 30, 2015. Initial screening was performed using a 12-lead

ECG when patients presented with suspected SVT. Patients older than 18 years old were included and patients with unstable blood pressures (systolic <90 mm Hg) were excluded. In addition, patients were excluded if contraindications to the Valsalva maneuver were present, atrial flutter or atrial fibrillation was suspected, or if the patient could not lay flat or tolerate the Valsalva maneuver as described to them. During the enrollment period, 1170 patients presented with suspected SVT, 711 were screened, and 433 were randomly assigned to either the intervention group or the control group. There were 217 who were to receive the intervention and 216 who were to receive the control. Two patients in the control group and three in the intervention group were excluded because of repeat enrollment. This screening resulted in 214 patients enrolled into the intervention group and 214 patients enrolled into the control group. Participants were randomly assigned using serially numbered, opaque, sealed, tamper-evident envelopes prepared by an independent statistician.[7]

In this study, the standard Valsalva was performed by having the patient sit in a semi-recumbent position at 45^{o} and blow into (strain) a pre-cut piece of suction tubing to a pressure of 40 mm Hg for 15 seconds. The patient was to remain in this sitting position for at least 60 seconds before a 3-lead reassessment ECG was performed. The modified Valsalva maneuver was performed by having the patient sitting in the same semi-recumbent position as described in the standard Valsalva maneuver. While in this semi-recumbent position, the patient was instructed to blow into suction tubing (strain) for 15 seconds, and immediately following the strain the patient was laid flat and their legs were raised by a member of the staff to a 45^{o} for 15 seconds. Patients were then allowed to return to semi-recumbent position for 45 seconds before a 3-lead reassessment ECG was

performed. If NSR was not achieved after the initial attempt, one additional attempt was made before a 12-ECG was performed.[7]

There were 37 of the 214 participants (17%) in the control group (standard Valsalva) who reached the primary outcome of returning to NSR. There were 93 of the 214 participants (43%) in the intervention group (modified Valsalva) who achieved the primary outcome of returning to NSR following treatment. Of the patients that returned to NSR following either treatment, most returned to NSR with just one treatment of either the modified or standard Valsalva. However, 9 patients in the standard Valsalva group and 18 in the modified group required a second attempt to reach the primary outcome of returning to NSR.[7]

Walker et al

This study[11] was referred to in the *Appelboam et al* study[7] as the only study found to compare a postural modification of the Valsalva maneuver to a standard Valsalva on human subjects in the emergency department. This was a prospective observational case study with a retrospective case review. The prospective arm of the study included the intervention of the modified Valsalva and the retrospective case review was the control arm of the study. The investigators were interested in describing and perhaps standardizing a Valsalva maneuver that could be used to convert SVT to NSR in the emergency department. They believed that there was a lack of studies describing the most effective method for performing the Valsalva maneuver for patients presenting to the emergency department in SVT.[11]

The retrospective arm of the study included a 6-month audit of patient presentations to a single emergency department in Leeds England from Feb 1, 2006 to

July 31, 2006. In addition to the audit, the investigators developed a questionnaire for emergency room providers to complete that would help describe how the standard Valsalva was being performed in the emergency department during the time of the audit. The prospective arm of the study was performed between Feb 1, 2007 and Feb 1, 2008 and all patients suspected of SVT presenting to the Leeds emergency department were considered for the study.[11]

The modified Valsalva maneuver performed in this study consisted of the patient lying supine on an ED department bed (or "trolley" as described) and then the head of the bed was lowered so the patient was in Trendelenberg position. This would place the patient in a head-down position of 10-15^{o} (depending on bed model). Next, the patient would be given a 20-cm precut length of suction tubing connected to an aneroid pressure gauge and instructed to blow as hard as possible (strain) and sustain a minimum pressure of 40 mm Hg for at least 15 seconds. If this initial maneuver was unsuccessful, the maneuver was repeated up to 3 times with a 1 min rest in between attempts. If the primary outcome was still not achieved, and the patient remained in SVT, then adenosine was administered per ED protocol.[11]

The retrospective case review audit resulted in 19 cases of confirmed SVT and documentation of nine attempted vagal maneuvers with one successful return (5.3%) to NSR. The 18 remaining patients received adenosine and there was no mention of how the Valsalva (vagal) maneuvers were performed. The prospective observational study resulted in 19 patients with confirmed SVT. Following the modified Valsalva as described above, 6 of the 19 (31.6%) returned to NSR. There was no mention in this study of how many attempts were required to reach outcome of return to NSR.[11]

Discussion

A Valsalva maneuver is assumed to be the first-line treatment for SVT presenting to the emergency department; however, there is no standardized method for performing the maneuver. The resultant data from the two studies[7,11] in this systematic review implies that standardizing a specific method to perform the Valsalva maneuver, which includes patient position, force and duration of strain, and post-strain leg elevation would increase the effectiveness of the maneuver. The standard Valsalva maneuver described in the RCT study by Appelboam et al[7] resulted in 17% conversion from SVT to NSR as compared to 5.3% conversion in the retrospective case review described within the study by Walker et al.[11] This difference suggests the possibility that standardization alone may increase conversion rates independent of a modified Valsalva and even result in less use of adenosine or other more costly and invasive treatments for SVT.

Both studies[7,11] included in this systematic review have shown that a modified postural approach to the currently accepted Valsalva maneuver can increase the rate of cardioversion from SVT to NSR in adults presenting to the emergency department. The study by Appelboam et al[7] had a higher rate of conversion as compared to the study by Walker et al[11] (see Table 2). This higher rate of conversion may be due to the fact that the maneuver described by Appelboam et al[7] was slightly different than the maneuver described by Walker et al.[11] While a non-invasive approach to SVT cardioversion is desired, the Valsalva maneuver does have its limitations due to contraindications as previously described, including: recent MI, retinopathy, aortic stenosis, or glaucoma.

Unfortunately the two studies[7,11] described in this review are the only two, which directly compare a standard Valsalva maneuver with a modified Valsalva maneuver. In

addition to the lack of published data on the subject, the modified maneuvers described in each study are not exactly the same concerning patient position before and after strain. This variability between the methods within the studies is an obvious weakness with regards to comparing the two studies; however, in both studies a modified Valsalva was superior to a standard Valsalva (see Table 2).

The two studies included in this systematic review are not without limitations. The study by Appelboam et al[7] contained an equal number of patients in both the treatment and control group. However, the 214 patients in each group are a relatively small sample size, but larger than the treatment group of 19 in the study by Walker et al. There were 164 different clinicians who delivered the intervention in both the control and treatment group in the Appelboam et al study[7] which could imply variation across treatment. However, the simple instructions and minimal technical expertise required to perform the maneuver may outweigh the relatively large number of clinicians overseeing the maneuver.

Neither the Appelboam et al[7] or Walker et al[11] study included children in their participant groups. This could be a study in the future as pediatric SVT is relatively common.[3] There was mention of the successful use of the modified Valsalva on children described in the study by Walker et al,[11] but these were completed following the study and not included in the data. Concerning the standard Valsalva maneuver retrospective case review in the Walker et al study, there was no actual standardization of the maneuver which is a significant limitation. However, comparing the rate of cardioversion in the Walker et al study for standard Valsalva (5.3%) vs. the rate reported in the

Appelboam et al study for standard Valsalva (17.3%) implies that standardization alone may increase effectiveness of the maneuver.

Considering the above-mentioned limitations, future studies could include a pediatric study where a standard Valsalva maneuver is compared to a modified Valsalva maneuver. It would be interesting to investigate how standardization of the maneuver alone can increase effectiveness. Another retrospective case review vs. a standard Valsalva maneuver could provide insight into this question.

Conclusion

The use of a modified Valsalva maneuver for patients presenting to the emergency department in SVT is a low cost and safe treatment for returning patients to NSR. Simply standardizing a single method for performing a Valsalva maneuver could possibly increase the effectiveness of this vagal maneuver. The Appelboam et al study modified the procedure described by Walker et al, and in doing so increased the effectiveness from 31.2% to over 40% conversion from SVT to NSR. This improvement came from a slight modification and could be performed without additional resources. These studies were performed in hospitals across the UK, but the medicine and procedures described within can cross borders and be applied to emergency departments around the globe. Implementing a standardized Valsalva into emergency departments could be a relatively simple procedure requiring a few training hours in the department to ensure all providers perform the procedure in the same manner.

Standardizing an accepted postural modification to the standard Valsalva is critical to having a better chance of consistent effective cardioversion in the ED setting and beyond. Comparing the retrospective case review of a standard Valsalva to the

standard Valsalva in the RCT supports this statement. At the very least, emergency departments here in the United States could certainly benefit from an additional non-invasive and cost-effective treatment for a relatively common cardiac dysrhythmia.

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Table 1. Characteristics of Reviewed Studies, GRADE Profile

Quality Assessment							
		Downgrade Criteria					Quality
Study	Design	Limitations	Indirectness	Imprecision	Inconsistency	Publication Bias Likely	
Modified vs. Standard Valsalva							
Appelboam et al	RCT	Not Serious	Not Serious	Not Serious	Not Serious	No	High
Walker et al	Observational	Serious[a]	Not Serious	Serious[b]	Not Serious	No	Very Low

[a] Use of retrospective case review which lacked a standardized approach for performing Valsalva maneuvers
[b] Small sample size

Table 2. Summary of Results: Modified vs. Standard Valsalva by Study

Study	Number in Study	Type of Valsalva Maneuver	Converted with Intervention	P value
Walker et al	19	Standard	1 (5.3%)	NA
Appelboam et al	214	Standard	37 (17.3%)	p<0.0001
Walker et al	19	Modified	6 (31.6%)	p=0.09
Appelboam et al	214	Modified	93 (43.5%)	p<0.0001